

CIRCULAR No. 107.

OCTOBER, 1913.

SPRAYING WALNUT TREES FOR BLIGHT AND APHIS CONTROL.

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There are many orchards of thrifty, large seedling walnut trees in the State, particularly in Santa Barbara, Ventura, Los Angeles, and Orange counties, which would be much more profitable than at present were it not for the attacks of walnut blight and aphis. The development of new walnut varieties more resistant to blight presents no relief to the owners of these groves, since most of their best walnut land is already occupied by large trees, and these trees, moreover, are of a good commercial type and would yield very good returns save for these two pests. The only apparently feasible means of combating blight and aphis on such trees lies in the development of some practical spraying method.

The necessity of controlling aphis as well as blight is apparent to every walnut grower, since this pest has in recent years become really more serious than the much dreaded blight. Spraying experiments carried on by this Division several years ago seemed to show the impracticability of controlling blight by spraying, on account of the time and expense required for treating such large trees by ordinary spray methods. Recent developments, however, in sprayers and nozzles have made it possible to spray large trees more quickly and cheaply than could be done a few years ago, and we therefore decided last year to try out again the possibilities in this direction. In this connection a considerable acreage of walnut trees was sprayed, using various methods and mixtures. As a result of the work, it may be said in brief that one method gave particularly promising results, especially in the control of the aphis. This method consisted in spraying the trees, while they were in a dormant condition, with lime-sulphur solution.

Effect on Blight.

The results of the spraying upon the walnut blight were difficult to establish on account of the slight occurrence of the disease in the sprayed districts during the past season. In this respect the work was

inconclusive, although there appeared to be at least some blight control by the lime-sulphur spraying. It is further to be said that there is some experience to indicate that continued spraying with the lime-sulphur for two or three seasons gradually decreases the amount of blight.

Effect on Aphis.

Walnut aphis has in recent years become a worse pest than blight in many of the most important districts. This insect spreads the blight and multiplies its infections by carrying the germ as it crawls about the trees. Further, it reduces the vitality of the tree, checks its growth, reduces the size and weight of the nuts and contributes to the occurrence of "perforation," "stick-tights" and other conditions which decrease the crop and increase the cost of handling the nuts. The effect upon aphis of spraying trees with lime-sulphur during the winter time has been well marked in our work during the past season. Well sprayed trees remained comparatively free of aphis long after the insect had become abundant on unsprayed trees. The nuts of sprayed trees were larger and cleaner, the foliage cleaner and more vigorous looking and the growth of the trees continued later in the season. The spraying was done in each case upon a few rows surrounded by unsprayed trees and from the latter the aphis finally spread to some extent to the trees which were sprayed. It is reasonable to expect that if whole orchards had been treated the aphis control obtained would have been still better. The results of these experiments were so promising that we feel justified in carrying the work farther and urging growers to take up the work on their own account during the coming season.

Formula.

Our best work was done with the following mixture:

Commercial lime-sulphur solution	5 gallons
Quick lime	25 pounds
Water	95 gallons

The lime is slaked, strained and then added to the mixture. So far as we know the addition of the lime is not necessary to the effect of the spray, but this was added in order to make it easier to see it upon the trees. The trees are usually large and without the addition of lime it is very difficult, especially for inexperienced workmen, to cover the trees thoroughly without missing more or less of the twigs and branches.

Time of Spraying.

The work was intended to be done while the trees were in a dormant condition, *i. e.*, during the months of February and March. The solution burned the foliage severely if any leaves were out when the work was done, but it is possible that the aphis is more susceptible at this time.

Outfit.

In order to spray by this method, a power outfit must be used which will maintain a constant pressure with two lines of hose of 200 to 250 pounds. A pressure of 200 pounds at the very least is necessary in order to cover the tops of tall trees thoroughly by this method.

In regard to nozzles, our best results were obtained by spraying the trees with the so-called M. A. C. nozzle—a special nozzle made in the East for this sort of work. Some preferred using an outfit with two lines of hose, one man spraying the upper part of the trees with this nozzle while the other sprayed the lower parts with an ordinary Bordeaux or Cyclone type of nozzle. The largest walnut trees can be sprayed entirely from the ground by the use of the M. A. C. nozzle if the proper pressure is maintained.

Method.

The whole success of the work depends upon thoroughly coating the trees out to the tips of the smallest twigs with the spray solution. This, with large walnut trees, is a somewhat difficult and laborious task and also an expensive one. By using the type of nozzle suggested, however, and working with intelligence toward covering all the growth quickly and at the same time thoroughly, workmen can acquire much skill in this respect and the work can be done economically enough to more than justify its expense. Herein, however, lies the whole secret of the operation: that is, spraying rapidly and yet thoroughly.

Amount of Material Required.

In our work last winter the amount of material used varied in different places from 25 to 67 gallons per tree. These were trees of varying size, but it is still to be considered that as the work progressed and the workmen became more experienced, it became possible to spray larger trees with a smaller amount of material and at the same time do the work even more thoroughly. It may be said upon this point that about 25 gallons of spray to a tree will be required to cover fair to middle-sized walnut trees thoroughly—that is, trees of average size up to about ten years of age—while large trees will average about 40 gallons per tree.

Time Required.

With a power sprayer having three men on the outfit and another to mix, or seven men to two outfits, we averaged about 85 large trees per day to each outfit. In one case an average of 110 fair sized trees per day was made, while in another case 40 per day was averaged for trees of the very largest size. The time required varies naturally with the facilities for loading up. In our work the spray outfit went after its load each time to the mixing station and the distance thus covered varied in different places. A little time could be saved profitably in extensive work by hauling or piping the mixture out to the spray rig in the orchard.

Expense.

Materials were purchased at a price of \$10 per 50 gallon barrel of commercial lime-sulphur solution, and \$1.10 per hundredweight for lime. On this basis the spray in the proportion recommended above cost \$.01275 per gallon. The expense of application was estimated on the following basis for each power outfit:

	<i>Per day.</i>
Four men at \$2.00 each-----	\$8 00
Two horses at \$1.00 each-----	2 00
Depreciation of outfit-----	2 00
Oil and gasoline-----	1 00
Total -----	<u>\$13 00</u>

On this basis the expense of application per gallon varied from \$.004 to \$.007. Assuming an average expense of application at \$.00525 and that for material at \$.01275, we get a total expense of \$.018 per gallon on the tree. At this rate, 25 gallons per tree would cost \$.45, while 40 gallons would cost \$.72 per tree, total expense of material and application.

Consideration of Expense.

It will be seen that the cost of this work is by no means prohibitive if even a moderate degree of blight and aphid control be obtained. It is also to be considered that beneficial effects would almost certainly be cumulative, so that after spraying trees for two, or at most three, successive seasons the work could very probably be discontinued for a year or two without throwing the trees back into as bad condition as they were in the beginning.

Furthermore, it is altogether probable that the cost estimated above could be reduced to a considerable extent by carrying on systematic work on a large scale. In the expense for material and labor the cost of the commercial lime-sulphur solution amounts to an average of about 55 per cent of the total cost. The labor item averages about 30 per cent of the total and the lime makes up the remaining 15 per cent. It is probable that the lime could be omitted altogether when the workmen became skilful enough to spray the trees thoroughly without such an indicator to make the material more easily seen; this, so far as we know, is the only object of using the lime. The lime-sulphur solution is estimated at the prevailing retail price and it is possible that by buying in large quantities (for instance, through walnut associations), a better rate could be obtained. It is also possible that the associations or even the growers could prepare the materials themselves at a lesser cost than that estimated. The labor item will be reduced as the workmen become more skilful and could also be lessened to some extent, at least in large work, by arranging to deliver the material to the spraying outfits in the orchard more rapidly than was done in our experiments. Two ex-

perienced men could spray and run the outfit, rather than the three which we have estimated. One man could also mix the spray for a number of outfits. The amount of material used per tree can also be reduced somewhat as the workmen become more experienced. Altogether, it appears to us possible that the expense of spraying trees of average large size by this method may be ultimately reduced to about fifty cents per tree. We do not, however, look for much further reduction than this, unless some much cheaper spray material is found to be effective. The work can not be done properly without using comparatively large amounts of time and material. At \$.50 per tree, a very moderate degree of success in aphid control alone would be a most profitable investment in the increased growth of the tree and yield of nuts, as well as the improvement in quality and reduction in cost of handling the nuts.

Further Work.

We recommend to large growers and associations especially that work along this line be taken up during the coming season, in order to test more fully the value of this spraying. We recommend that entire orchards or blocks of trees be sprayed, in order that a more complete test may be obtained than that which results from spraying a few trees or rows in the midst of other unsprayed trees. We do not guarantee spectacular results from such work, but do believe that if it is done thoroughly the effect will more than justify the expense. On the part of the University we expect to continue experimental spraying another season, testing some other promising materials, and will also agree to furnish co-operation to all who undertake the work to the extent of general oversight, information and suggestions. We should also be glad to take up the matter of the purchase of apparatus with all who contemplate walnut spraying, in order that they may obtain the right sort of appliances and have them in ample season.

ILLUSTRATIVE RESULTS.

Bishop Ranch, Goleta: Very large, old trees. March 26-30, 1913.

Formula.

5 gallons Ortho lime-sulphur solution, 25 pounds lime, to 100 gallons of spray mixture.

Quantity.

11,600 gallons applied to 173 trees.

Labor.

4½ days at \$13.00.....	\$58 50
3 spray men at \$2.00.....	\$6 00
1 mixer at \$2.00.....	2 00
2 horses at \$1.00.....	2 00
Depreciation of outfit.....	2 00
Oil and gasoline.....	1 00

Total\$13 00

Labor = \$.005 per gallon.

Material.

580 gallons lime-sulphur at \$.20	-----	\$116 00
2,900 pounds lime at \$1.10	-----	31 90
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		\$147 90
Material	-----	\$.01275 per gallon
Labor	-----	.005 per gallon
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Total	-----	\$.01775 per gallon

Total Amount Applied.

67 gallons per tree = \$1.19, total expense per tree.

Expense Summary.

Labor	-----	\$58 50 = 28½ per cent
Lime-sulphur	-----	116 00 = 56½ per cent
Lime	-----	31 90 = 15 per cent

RESULTS.

This work was done with extreme thoroughness and some wasting of material. The trees were some of the largest in the State, however, and very difficult to cover thoroughly. Not enough blight developed during the following season to afford definite indications as to blight control by the spraying. The effect upon aphids was well marked, the sprayed trees being noticeably free from this pest quite late in the season. The foliage on trees which were partly in leaf at the time of the spraying was badly burned by the solution.

Robert Main Ranch, Goleta: Medium sized trees. March 31-April 1, 1913.

Formula.

5 gallons Ortho lime-sulphur solution, 25 pounds lime, to 100 gallons of spray mixture.

Quantity.

4,800 gallons applied to 165 trees.

Labor.

1½ days at \$13.00	-----	\$19 50
3 spray men at \$2.00	-----	\$6 00
1 mixer at \$2.00	-----	2 00
2 horses at \$1.00	-----	2 00
Depreciation of outfit	-----	2 00
Oil and gasoline	-----	1 00
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Total	-----	\$13 00

Labor = \$.00406 per gallon.

Material.

240 gallons lime-sulphur solution at \$.20	-----	\$48 00
1,200 pounds lime at \$1.10	-----	13 20
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		\$61 20
Material	-----	\$.01275 per gallon
Labor	-----	.00406 per gallon
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Total	-----	\$.01681 per gallon

Total Amount Applied.

29 gallons per tree = \$.48749, total expense per tree.

Expense Summary.

Labor	-----	\$19 50 = 24½ per cent
Lime-sulphur	-----	48 00 = 59½ per cent
Lime	-----	13 20 = 16 per cent

RESULTS.

The foliage on these trees was considerably advanced when the spraying was done and the leaves and young shoots were badly burned, so that a large amount of the new growth fell off. Another growth developed on the trees, but the crop was considerably cut down by this injury. The effect on aphid control was excellent, the sprayed trees being noticeably clean late in the summer, the nuts and leaves larger and the growth of the trees more vigorous later in the season. There appeared to be rather less blight on the sprayed than on unsprayed trees, but the disease was not abundant enough to warrant positive conclusions.

Limoneira Ranch, Santa Paula: Medium large trees. April 2-4, 1913.

Formula.

5 gallons Ortho lime-sulphur solution, 25 pounds lime, to 100 gallons of spray mixture.

Quantity.

5,000 gallons applied to 200 trees.

Labor.

(2 outfits).

1½ days at \$24.00-----	\$36 00
6 spray men at \$2.00-----	\$12 00
1 mixer at \$2.00-----	2 00
4 horses at \$1.00-----	4 00
Depreciation of outfits-----	4 00
Oil and gasoline-----	2 00
Total -----	\$24 00

Labor = \$.0072 per gallon.

Material.

250 gallons lime-sulphur at \$.20-----	\$50 00
1.250 pounds lime at \$1.10-----	13 75
	\$63 75
Material-----	\$.01275 per gallon
Labor-----	.0072 per gallon
Total -----	\$.01995 per gallon

Total Amount Applied.

25 gallons per tree = \$.50, total expense per tree.

Expense Summary.

Labor-----	\$36 00 = 36 per cent
Lime-sulphur-----	50 00 = 50 per cent
Lime-----	13 75 = 14 per cent

RESULTS.

These trees were scarcely in leaf when the spraying was done and consequently no serious burning resulted. The sprayed trees were noticeably more free from aphid than the unsprayed quite late in the season. The leaves and the nuts were cleaner and somewhat larger and more thrifty. The trees also seemed to maintain their growth later in the season. This grove was situated upon heavy land, with irrigation, and did not develop as much aphid upon unsprayed trees as in most cases.

SUMMARY.

Aphis and blight are the two most serious pests of the English walnut. In the experiments described in this circular very promising results in the control of aphis were obtained and there is reason to believe that blight may be controlled, to some extent at least, by the same means.

The best results were obtained by spraying the trees while in a dormant condition (or just as the first growth was starting), with lime-sulphur solution. The proportion used consisted of 5 gallons of commercial lime-sulphur to 95 gallons of water. Twenty-five pounds of quicklime, slaked and strained, was also added, to make the spray more visible upon the trees.

The problem of spraying such large trees quickly and economically was met by the use of high power sprayers and a special nozzle (the so-called M. A. C.), making it possible to cover the largest trees completely from the ground.

The essential thing for success in this work is to cover the trees absolutely with the spray, from the trunks to the tips of all the twigs.

The amount of material required for spraying good sized trees thoroughly averaged from 30 to 50 gallons per tree.

The average cost of material was \$.01275 per gallon; that for labor and other expenses of application \$.0055 per gallon; the average total cost per tree being about \$.55. This may probably be reduced to \$.50 per tree for average large trees, by having experienced workmen and buying or making the spray material in large quantities.

An average of 85 large trees per day was sprayed by one outfit with four men (or seven men to two outfits).

The results obtained, while not accurately measurable the first year in pounds of walnuts, seemed to more than justify the cost in improved condition and increased growth of the trees, nuts and foliage.